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What Should Social Distancing Really Look Like?

Introduction

Over the last few months, our world has changed incredibly because of coronavirus. In the first few weeks of this disease becoming a global epidemic, we saw hundreds of data science and epidemiology experts producing their own models that explained how coronavirus transmission would expand across the United States. The bottom line was, by flattening the curve, we could reduce the peak number of infections. People all over the work took these recommendations to heart and self-quarantined. We also know, that by flattening the curve, we increase the time it takes for system equilibrium to be achieved, which lengthens the duration of the economic shutdown across the world.

Social distancing can work, it can be a very effective tool if everyone does it. In places like Korea and Singapore, where the government utilized tremendous amounts of resources to ensure people stayed quarantined and those that are sick have minimal exposure to healthy people, we see low number of cases.

Through the development of coronavirus, there has been significant discussion about the risk levels of young healthy people versus the elderly and immunocompromised. In this paper, we will examine how the situation changes when we make some assumptions around this statement. Firstly, we will discuss what happens if we are able to identify which people are at high risk. Then, we will look at the landscape when the percentage of people that are at high risk changes.

Baseline COVID-19 Model

Figure 1, below, indicates how peoples' status changes as coronavirus spreads through their ecosystem. These results were calculated using an agent-based simulation where 80,000 people interact with each other within an ecosystem.

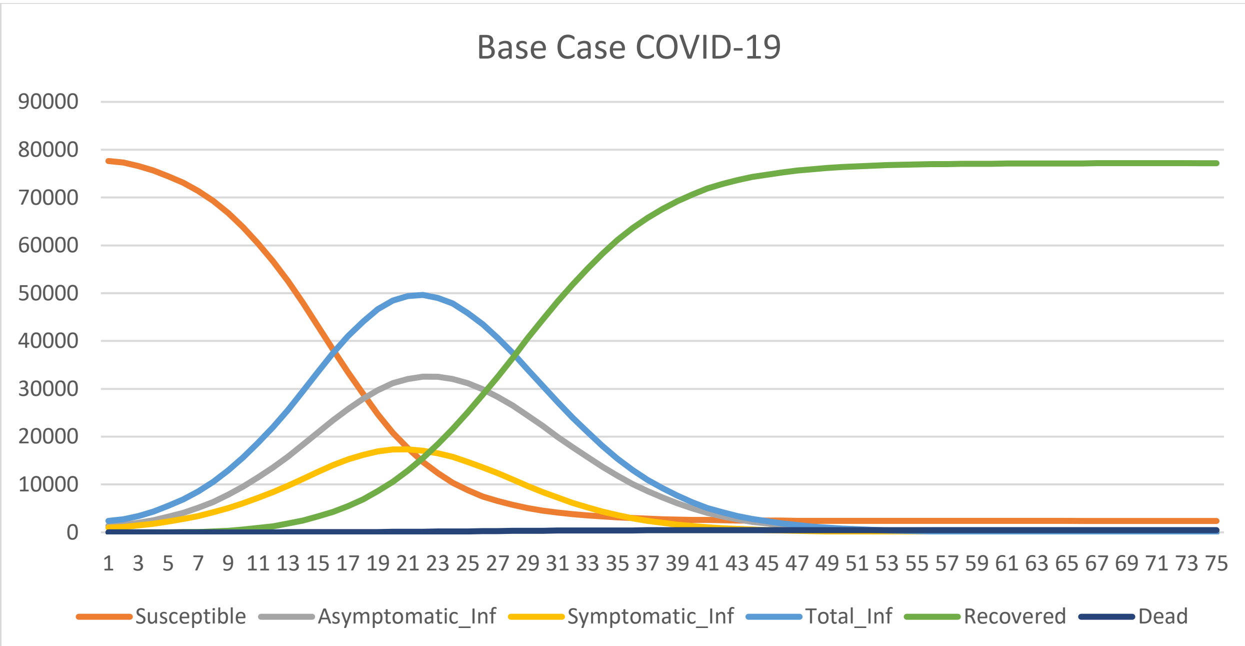

Figure 1. Base Case for COVID-19. Progression of person state over time

Figure 2, below, states the parameters and assumptions made in this model. Essentially, by determining how people interact with each other and the rates of transmission, we see an output that looks a lot like an SIR model without necessarily having insight to the gamma, beta, and R0 values associated with a disease.

Scope	Parameter	Description	Value
Global	Death Rate	If a person is symptomatic the chance that they die	1.5%
Global	Percent Asymptomatic	The percent of people that get COVID but are asymptomatic	60%
Global	probCatch	Probability that the disease is transmitted to you given you are in contact with someone who has it	30%
Person	Time Asymptomatic	If a person is asymptomatic, how long they remain contagious	N(14,1)
Person	Time Symptomatic	If a person is symptomatic, how long they remain contagious before recovering or dying	N(10,1)
Person	Behavior	The amount that this person social distances on a scale of (0-10). 0: Locked in their bedroom and has 0 exposure to others. 10: Actively interacting with others.	N(5,1)
Person	Environment	The population density of the community in which this person lives on a scale of (0-10). 0: Lives in small rural town. 10: Lives in a populated apartment building in NYC	N(5,1)

Figure 2. Assumptions made for the Base Case

From this case, we come away with a few deep insights, that are highlighted in the table below.

	# People	Average Behavior
Status.Dead	470	5.053138215
Status.Recovered	77114	5.02336566
Status.Susceptible	2416	4.264592968
Grand Total	**80000**	**5.000625638**

Figure 3. Equilibrium Status within Ecosystem

Once equilibrium is reached, there are still people who haven't contracted COVID-19. These people are classified as Status.Susceptible. The characteristics of those who fall into this category have significantly higher social distancing tendencies than others, indicated by their lower behavior level than others. Just a 15% decrease in social interaction seems to have a significant effect. Social distancing does work!

Changing Behavior Based on Risk

Common storylines during this pandemic have been the college students crowding the beaches in Florida, the thought that kids are not affected by COVID-19 even if they have it, and the shock when we find out that a young individual died as a result of COVID-19. Common to all these stories is the assumption that there are some people who are high risk and some who are low risk. Though the White House, CDC, or WHO haven't officially defined a criterion for making this designation, the underlying assumption has been driving decision making regarding resource allocation in the U.S. For example, I have many friends who have been denied testing even though they present symptoms because medical professionals believe that they are at lower risk of death.

Given this assumption, I wondered what would happen if people knew whether they were at high risk or low risk. I think that some people might change their behavior tremendously. If they do, are they really putting everyone else at significantly higher risk as the experts say they are?

To evaluate this question, we create two categories of people:

1) 10% are high risk with a death rate of 10% and behavior level of 2

2) 90% are low risk with a death rate of 0.056%. The behavior level is the independent variable and varies from 5 – 10 at 0.5 increments

This breakdown maintains the 1.5% death rate for COVID-19 and allows us to examine if social distancing really is the best solution.

It is obvious and well-known that when we allow people to engage with social interaction, we see an increase in the peak. We see this in Figure 4. My argument though, is that this increase isn't necessarily bad, and our optimal goal shouldn't be to minimize the peak but should be to minimize the number of deaths without overwhelming medical resources.

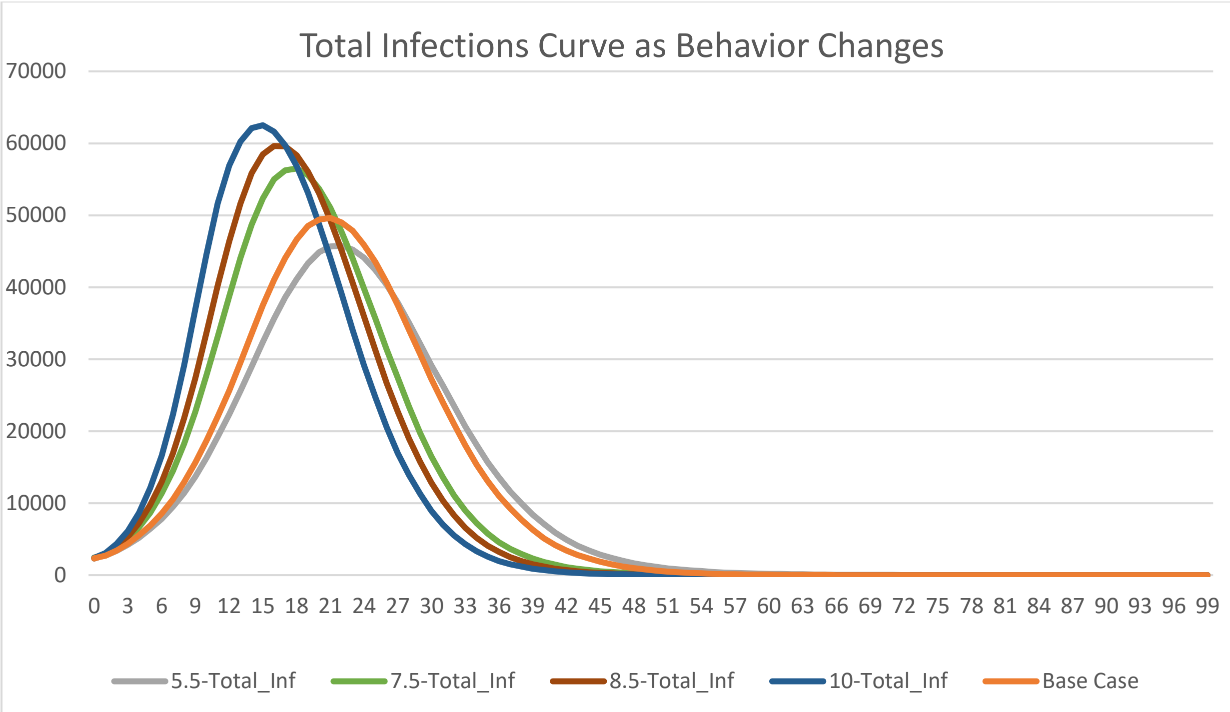

Figure 4. Total Infections as the low risk individual behavior increases

There are two notable takeaways from Figure 4, which shows the total infections as we adjust the low risk individuals' behavior levels. First, once we segment the population, we see that even by increasing the low risk behavior by 10% to 5.5, we see a lower peak. Secondly, the peak increases as behavior levels increase. At its peak, more than 75% of people are infected with COVID-19. However, what may surprise you, is that despite this increase in the number of cases, a lot of which are asymptomatic, the number of deaths experienced doesn't increase at the same scale as seen in Figure 5.

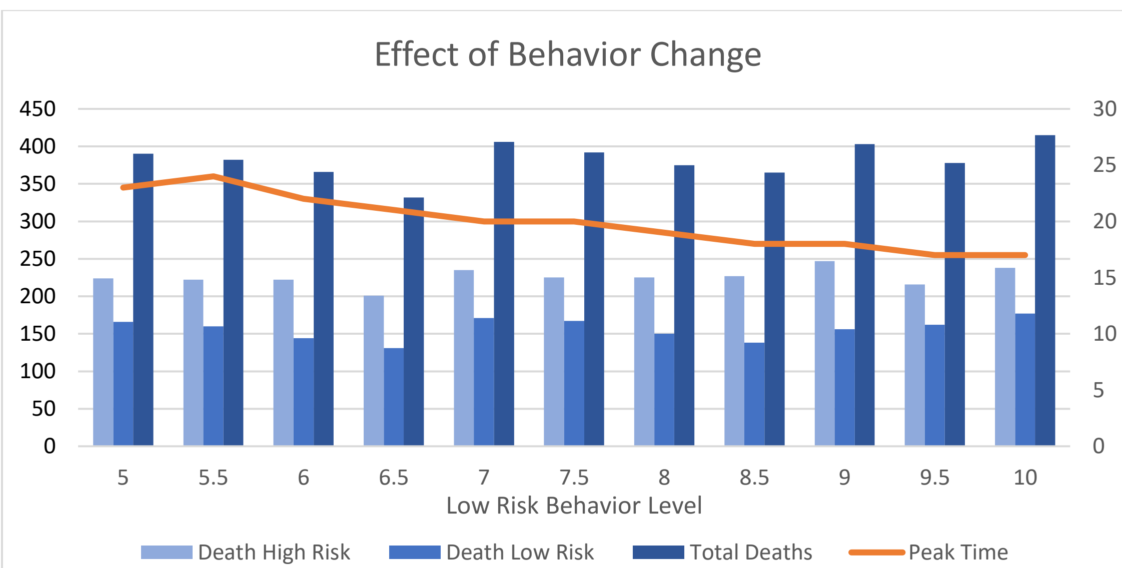

Figure 5. Death counts and peak time for various behavior levels

In fact, what we see is the total number of deaths is relatively constant as the behavior of low risk individuals' changes. How can this make sense? Well, the people who are interacting and getting the disease are much less likely to die once they get it. In fact, the ratio of the total deaths to the maximum number of people infected has a negative correlation.

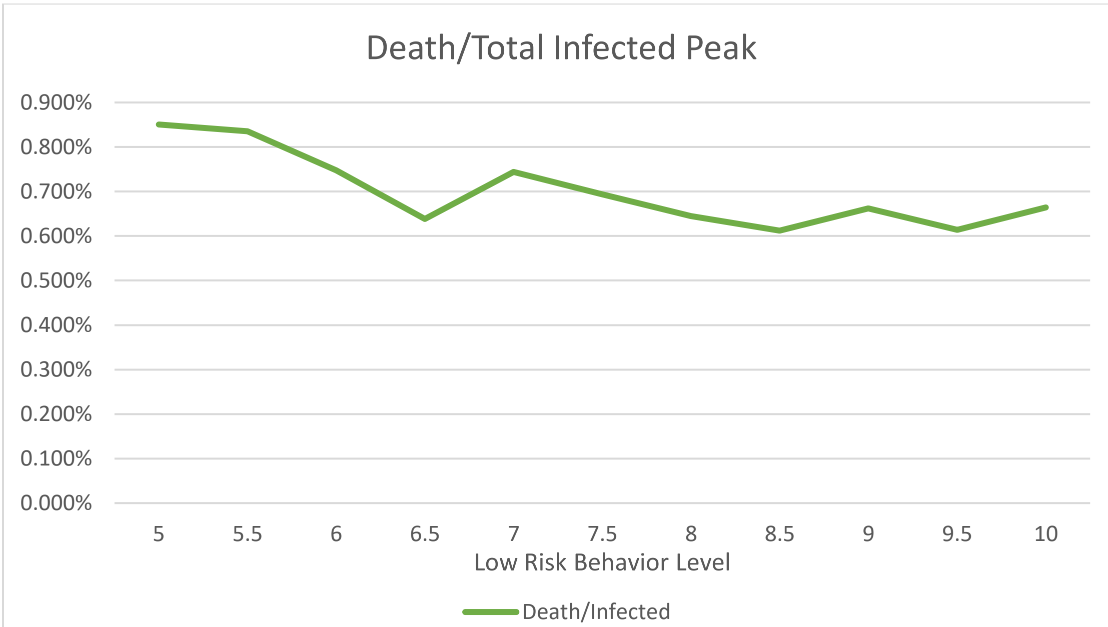

Figure 6. Ratio of deaths to maximum number of infected people

Given this information, I wonder if the best strategy really is to flatten the curve and extend the indirect effects that comes along with this disease. Could it potentially be a better solution to achieve a peak infection count quickly and minimize the effects of a halted economy and the mental effects of forcing inherently social people to quarantine? Countries like Sweden are employing this strategy though its success is yet to be seen. The answer to this question really lies in the capacity of hospitals and the likelihood that symptomatic low risk individuals need to be hospitalized. I mean, today in real life, hospitals are making this decision.

In reality, this idea that knowing your risk level affects your behavior is inherently flawed during this time of trouble. During this time of coronavirus, we've seen organizations and communities come together for the benefit of the greater good. Some of the cultural spillover of this pandemic include feelings of selflessness and sacrifice of individualism. If we collected thick data by interviewing supposedly low risk individuals who are self-quarantining, we would hear that a lot of their actions are driven by the reality that they live with others that they care about. Some of their family members might be high risk, so they are making the decision to protect the ones they love and stay quarantined. When I think about this happening, it reminds me of some of the core tenants of communities and self-organization that Rebecca Hardin has spoken about. Something that she also mentioned, though, was, that while people may act this way in the medium-term, a few months, communities experience negative spillovers in the long-term when people who are low risk begin to think that the sacrifice may not be worth it.

Percent of Population at Risk

One difficult piece of implementing some policy surrounding this idea is that we don't quite know who or how many people are at high risk. In order to perform some analysis on this, I looked at how the total infections curve changes when we change the percentage of population at high risk. Here, we assume:

1) People who are at high risk, have a 10% death rate and have level 2 behavior
2) People who are at low risk, have level 5 behavior. These people have a death rate that results in an overall death rate of 1.5% until, the population of high risk individuals is too high to meet that overall average. At that point, the death rate becomes 0.01%.

In this experiment, the independent variable is the percent of population that is at high risk. It ranges from 0% – 100% at 10% intervals. At 0% high risk, all people behave normally as in the base case. When the % high risk is 100%, everyone has cut exposure by 80% and is quarantining quite effectively.

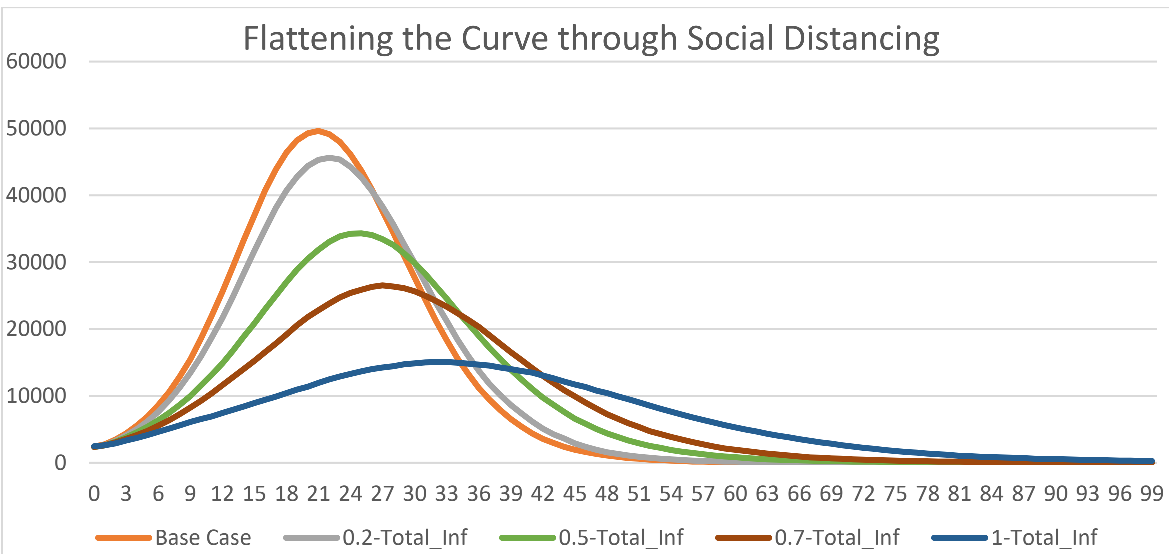

Figure 7. Total Infections as percent of population that his high risk changes

I believe that the death count in this model is only representative of reality until we reach 20% high risk population because at this point, the overall average death rate begins to increase from 1.5%, and we begin to explore a different disease scenario.

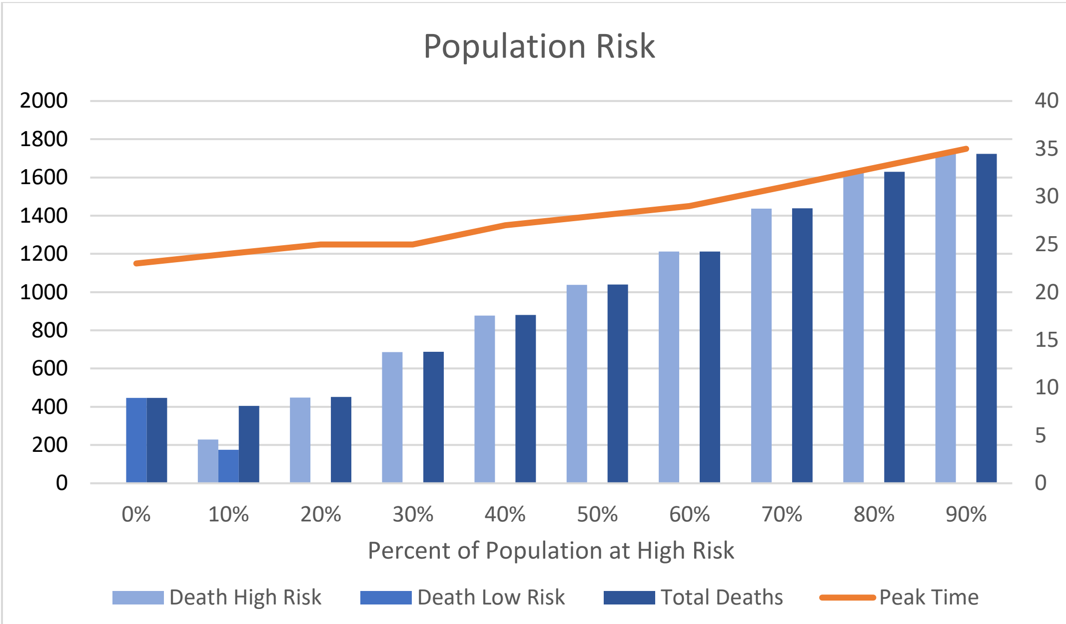

Figure 8. Death counts and peak time as percent of population increases

The major point I want to make from this example, is that even if we encourage social distancing, it doesn't necessarily suggest that less people will die. Because social distancing delays the peak and extends the time until equilibrium is reached, all individuals high risk and low risk, have increased opportunity of exposure to COVID-19.

Reservations

This analysis plays the role of sparking conversation and inducing new thoughts on the way to handle COVID-19. The limitations of this paper lie in the seemingly endless factors that introduce variability. How likely someone is to catch COVID-19 if they've been in contact? This answer will tremendously impact the results. Do we have any idea about the split between symptomatic and asymptomatic people? How do these numbers influence economics, society, and decision making? What does this data look like after aggregating 100 iterations of the model? Exploring some of these questions highlight the limitations of this paper but serve as starting points for further analysis.

Conclusion

Though this analysis doesn't help us understand the exact situation that is happening, it does help us understand what kind of effects different behaviors could have. We know that increased interaction may not be such a bad thing, if we can ensure that the right people are interacting. We need to know that these people will not flood the hospitals, but there isn't conclusive evidence that this is true. We also know that because of community, people are willing to make sacrifices in the medium term. Because of the spillovers of community institutions, this will likely not be the case in the long run, and we might end up seeing a second wave because of impatience. This analysis doesn't help us understand if it could be better to reach equilibrium before this happens or what the effects of a second wave will be.

Because there is no official way to designate low risk from high risk people, it is easier for administrative officials to send the message that we should all be in self-quarantine. I wonder if just because this is easy to do, is it the right strategy to employ?

Resources for this paper can be found here.